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Exploring face space: Linking perceived and measured face shape

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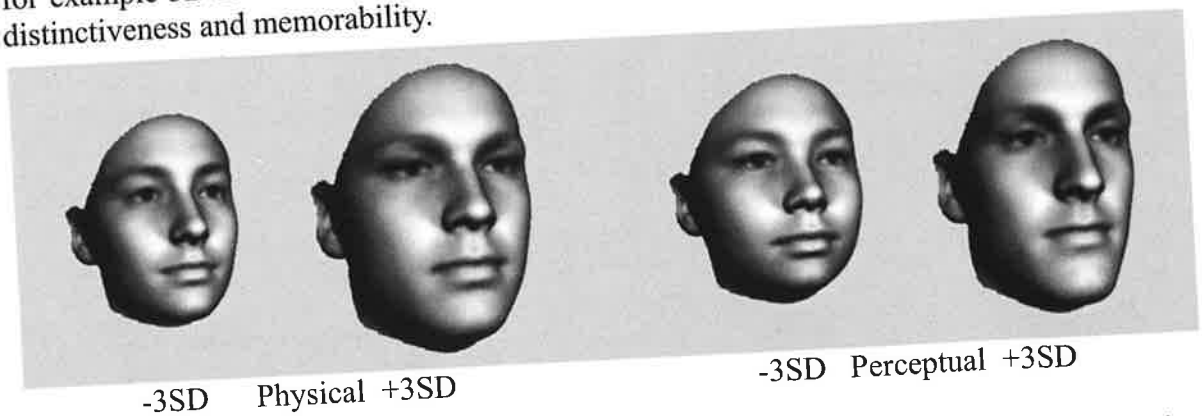
We link objectively measured three-dimensional (3D) shape to subjective perception through similarity. Physical similarity was defined within a 'face-space' based on principal components of the 3D positions of 12,016 corresponding points on face meshes fitted to 3dMD(TM) shape data for 224 individuals[1]. Perceptual face-spaces were defined on the basis of a sorting task where 34 observers arranged 60 of the 224 available faces into groups "that look similar"[2]. This was done with static as well as animated views as a test of dependence on viewing conditions.

Rv^3 was used as a measure of similarity between face-spaces. Physical and perceptual spaces were clearly related (Rv = .84), but not as closely as the animated and static perceptual spaces (Rv=.93). "Distinctiveness" based on distance from the center of perceptual space was also found to better correlate with d-prime for old/new face recognition (r=.56) than an equivalent physical space measure (r=.29), and similar to that for explicitly rated distinctiveness (r=.48). The perceptual space measure was more closely linked to false alarms (r=-.51) while rated distinctiveness linked to hits (r=.45). This suggests that perceptual face spaces may have useful predictive value with regards memorability above that offered by a physical face space and complimentary to that provided by distinctiveness ratings.

We visualize the dimensions of perceptual space through a combined PC space based on vectors that include position in both physical and perceptual faces space for the 60 faces sorted. This allows the direction of perceptual PCs to be expressed in terms of physical PCs and visualized as meshes: +/- 3SD on PC1 for both Physical and Perceptual spaces are illustrated below. We predict changes along the Perceptual dimension would be more discriminable and possible lead to greater adaptation. We also anticipate that using perceptual rather than physical spaces when designing applications for human observers, for example 3D reconstruction, would lead to advantages similar to those shown here for distinctiveness and memorability.



-3SD Physical +3SD -3SD Perceptual +3SD

(1) Claes, P., M. Walters and J. G. Clement (2012). "Improved Facial Outcome Assessment using a 3D Anthropometric Mask." International journal of oral and maxillofacial surgery **41**(3): 324-330.
(2) Abdi, H., Valentin, D, O'Toole, A.J. & Edelman, D. (2005) DISTATIS: The analysis of Multiple Distance Metrices. Proc. of the IEEE Computer Society: International Conference on Computer Vision and Pattern Recognition (CA, USA) pp 42-47
(3) Roberts, P., Escoufier, Y. (1976) A unifying tool for linear multivariate statistical models: the RV-coefficient. Applied Statistics, 25, 257-265.